A MEASUREMENT ISSUE REGARDING THE LINK BETWEEN A REGION'S CREATIVE INFRASTRUCTURE AND ITS INCOME

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Abstract

The creative capital possessed by the members of the creative class in region j is either acquired through education or present innately in these members. Therefore, the creative infrastructure (CI_j) in the jth region is the sum of a part (CI_j^E) representing creative capital obtained through *education* and a second part (CI_j^I) denoting creative capital present *innately* in the creative class members. A researcher wishes to estimate the true relationship between the jth region's log income per creative class member (y_j) and its creative infrastructure (CI_j). He has data on CI_j^E but not on CI_j^I. We study whether an ordinary least squares (OLS) regression of y_j on a constant and CI_j^E will produce an unbiased estimate of the impact of CI_j on y_j in two cases. In the first case, CI_j^E and CI_j^I are uncorrelated. In the second case, CI_j^E and CI_j^I are positively correlated.

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1. Introduction

1.1. Preliminaries and a definition

The concept of *creativity* in the context of cities was first discussed by Yencken (1988). Even so, there is no gainsaying the fact that the concept of creativity in general and the twin concepts of the *creative class* and *creative capital* that regional scientists, economists, and geographers are now so familiar with were first discussed and popularized by the urbanist Richard Florida.[1] In this regard, Florida (2002, p. 68) helpfully explains that the creative class "consists of people who add economic value through their creativity." This class is made up of professionals such as doctors, lawyers, scientists, engineers, university professors, and, notably, bohemians such as artists, musicians, and sculptors. From the standpoint of regional economic growth and development, these people are significant because they possess creative capital which is the "intrinsically human ability to create new ideas, new technologies, new business models, new cultural forms, and whole new industries that really [matter]" (Florida, 2005a, p. 32).

Closely related to the above concepts of the creative class and creative capital is the notion of a region's *creative infrastructure*. This notion has been used in different ways by different writers.[2] Even so, since our paper is fundamentally about a region's creative infrastructure,

[1] See Florida (2002, 2005a, 2005b) and Florida *et al.* (2008).

[2] Florida himself has used this notion on several occasions without---to the best of our knowledge---ever defining it concisely. For one such usage, see Florida (2005a, pp. 249-251).

we need to define what we mean by this notion. However, in order to understand this definition in the context of the Richard Florida inspired literature on the creative class, it is necessary to first comprehend the sense in which the concept of creative capital is *different* from the more traditional concept of human capital.

In empirical work in regional science and economics, the concept of human capital is typically measured with education or with education based indicators. This notwithstanding, Marlet and Van Woerkens (2007) have rightly pointed out that the accumulation of creative capital does *not* have to be dependent on the acquisition of a formal education. What this means is that even though the creative capital accumulated by some members of Florida's creative class (doctors, engineers, university professors) does depend on the completion of many years of formal education, the same is not necessarily true of other members of this creative class (artists, painters, poets). People in this latter group may be innately creative and thus possess raw creative capital despite having very little or no formal education.

Given this situation, Marlet and Van Woerkens (2007) are surely right when they say that there is little or no difference between the concepts of human and creative capital when the accumulation of this creative capital is a function of the completion of many years of conventional education. In contrast, there can be a lot of difference between the concepts of human and creative capital when the accumulation of this creative capital does not have to be a function of the completion of a conventional education. Because creative capital is of two types, it is a *more* general concept than the concept of human capital.

The discussion in the preceding two paragraphs tells us that the creative capital possessed by the members of the creative class in a region, say region j, is either acquired through education or present innately in these members. Therefore, let us define the aggregate creative infrastructure in this jth region (CI_j) to be the sum of two components. The first component (CI_j^E) represents the creative capital obtained through *education* and the structures that make the accumulation of this education possible. The second component (CI_j^I) denotes the creative capital present *innately* in the creative class members along with the structures that enable this innate creative capital to develop and flourish. The reader may want to think of the first or CI_j^E component as this jth region's *physical and scientific* infrastructure and the second or CI_j^I component as this same region's *artistic and cultural* infrastructure. In symbols, we have $CI_j = CI_j^E + CI_j^I$.

With this definition in place, let us point out that the creativity that a region's creative infrastructure engenders is concerned primarily with invention and innovation concerning either a good or service for consumption or a process whose use leads to the production of a good or service, once again, for consumption. Now, in their own ways, several researchers have pointed to a connection between a region's creative infrastructure and its welfare. Therefore, let us briefly review this literature and then proceed to the specific objective of our paper.

1.2. Literature review and specific objective

Batten (1995) has studied what he calls network cities and contended that the dynamism of such cities is very much a function of the extant creative infrastructure. Ho (2009) concentrates on Singapore and points out that policies are in place to grow creative industries by building infrastructure for a range of activities. Chapain and Comunian (2010) contend that in order to enhance the creative economy in two different regions in England, it will be necessary to account for the salience of regional infrastructure and the knowledge pool necessary to develop creative and cultural industries.

Comunian (2011) argues that instead of investing in regeneration projects or flagship developments, policymaking designed to promote creative cities ought to focus on the nature of the infrastructure, networks, and agents engaging in the city's cultural development. Similarly, Lee and Hwang (2012) concentrate on Seoul, South Korea and point out that the

city government's promotion of the notion of a creative city relies, in part, on the development of what they call physical cultural infrastructure.[3] Finally, concentrating on the United States, Florida (2004, p. 132) has said that "[t]he United States must invest generously in its creative infrastructure."

The papers discussed in the previous two paragraphs have certainly advanced our understanding of the connection between a region's creative infrastructure and its welfare. However, the extant literature about a region's creative infrastructure has *not* studied a basic measurement issue that arises when linking a region's creative infrastructure to its welfare. Consistent with the discussion in section 1.1, this measurement issue arises from the fact that a region's aggregate creative infrastructure can be thought of as the sum of *two* distinct components. Given this lacuna in the literature, our objective in this paper is to shed light on this measurement issue. In this regard, note that because we are focusing on a region's creative class that possesses creative capital, we shall use the logarithm of this region's income per creative capital unit or creative class member as a proxy for its welfare.[4]

The remainder of this paper is organized as follows. Section 2.1 delineates the problem faced by a researcher who wishes to estimate the true relationship between the jth region's log income per creative capital unit (y_j) and its aggregate creative infrastructure (CI_j). Since it is generally harder to obtain data on a region's artistic and cultural infrastructure (CI_j^I), we suppose that this researcher has data only on this region's physical and scientific infrastructure or CI_j^E and *not* on CI_j^I. Specifically, our researcher would like to know whether an ordinary least squares (OLS) regression of y_j on a constant term and CI_j^E will produce an *unbiased* estimate of the true impact of aggregate CI_j on y_j. To this end, section 2.2 derives an expression of the form $y_j = a + bCI_j^E + other\ terms$. Section 2.3 studies the unbiasedness of an OLS regression of the above sort in the case where CI_j^E and CI_j^I are uncorrelated. Section 2.4 does the same for the case in which CI_j^E and CI_j^I are positively correlated. Section 3 concludes and then offers two suggestions for extending the research delineated in this paper.

2. The link between a region's creative infrastructure and its income

2.1. Ordinary least squares estimation

Consider a stylized region j that is creative in the sense of Richard Florida and that is part of an aggregate economy of $j = 1, 2, \ldots, N$ regions. This jth region possesses creative infrastructure CI_j of the sort described in detail in section 1.1. Suppose that the true statistical relationship between the aggregate creative infrastructure CI_j and the logarithm of this jth region's income per creative capital unit y_j is given by

$$y_j = a + bCI_j + e_j, \tag{1}$$

where a and b are positive constants and e_j is an error term that has the standard statistical properties.

As noted in section 1.1, we have $CI_j = CI_j^E + CI_j^I$ and our researcher has data only on CI_j^E and not on CI_j^I. We assume that the two creative infrastructure components CI_j^E and CI_j^I

[3] In a related context, Suarez-Villa (1993) has contended that the ability of a region to become a center of invention depends critically on what he calls the "human capital infrastructure" of this region.

[4] Some members of the creative class possess more creative capital than others but every member of the creative class possesses some creative capital. Therefore, given the sense in which we are using the concepts of the creative class and creative capital in this paper, the creative class necessarily possesses creative capital.

in the jth region are uncorrelated with the error term e_j. Given this setup, our next task is to derive a linear relationship of the form $y_j = a + bCI_j^E + other\ terms$.

2.2. The linear relationship

Substituting the aggregate creative infrastructure expression $CI_j = CI_j^E + CI_j^I$ in equation (1), we get

$$y_j = a + bCI_j^E + bCI_j^I + e_j. \quad (2)$$

Equation (2) gives us the expression we seek. Three comments about equation (2) are now in order. First, observe that the weights on CI_j^E and CI_j^I in the equation $CI_j = CI_j^E + CI_j^I$ are implicitly equal to one. This means that the marginal contributions of these two distinct creative infrastructure components to the aggregate creative infrastructure in region j are identical. Since there is no existing empirical research on the *form* of the mathematical relationship between a region's aggregate creative infrastructure and its two constituent components, we believe that the intuitively most straightforward way to describe this relationship is to suppose that it is linear with weights of one attached to CI_j^E and to CI_j^I.

Second, given the discussion in the preceding paragraph, it is clear that when we substitute the expression $CI_j = CI_j^E + CI_j^I$ into equation (1) to get equation (2), we get a linear relationship in which the impacts of CI_j^E and CI_j^I on y_j are identical. This may appear to some readers to be a strong assumption but note that it logically follows from the additive specification $CI_j = CI_j^E + CI_j^I$ for which we have already made a case.

Finally, the discussion in the previous two paragraphs notwithstanding, if we had reason to believe that the effects of CI_j^E and CI_j^I on y_j are not identical then we could account for this feature explicitly by attaching *dissimilar* weights $w_j^E > 0$ and $w_j^I > 0$ to CI_j^E and to CI_j^I with the understanding that these two weights may or may not sum to one. This would be one approach a researcher could follow if he wanted to study the case where CI_j^E and CI_j^I have disparate effects on y_j. However, such an inquiry is beyond the scope of this paper and hence we do not pursue this matter any further.

Now, ideally, our researcher would like to run an OLS regression on equation (1) but he cannot do so because he does not observe and hence has no data on CI_j^I. Therefore, this researcher runs an OLS regression on

$$y_j = \alpha + \beta CI_j^E + e_j, \quad (3)$$

where α and β are positive constants. We know from standard econometrics---see Kelejian and Oates (1981, p. 56-57)---that the coefficient β in equation (3) can be expressed as

$$\beta = \frac{Cov(CI_j^E, y_j)}{Var(CI_j^E)}, \quad (4)$$

where $Cov(\cdot,\cdot)$ is the covariance function, $Var(\cdot)$ is the variance function, and y_j denotes the true log income per creative capital unit in region j and is given in equation (2).

Now, substituting the true log income per creative capital unit from equation (2) into equation (4), and then simplifying, we get

$$\beta = \frac{Cov(CI_j^E,\ a+bCI_j^E+bCI_j^I+e_j)}{Var(CI_j^E)} = b + \frac{bCov(CI_j^E, CI_j^I)}{Var(CI_j^E)} = b\left\{1 + \frac{Cov(CI_j^E, CI_j^I)}{Var(CI_j^E)}\right\}. \quad (5)$$

In writing equation (5), we have used the fact that because CI_j^E is uncorrelated with the error term e_j, we get $Cov(CI_j^E, e_j) = 0$. We are now in a position to ascertain whether an

OLS regression of y_j on a constant and CI_j^E will produce an unbiased estimate of the effect of the jth region's aggregate creative infrastructure on its log income per creative capital unit.

2.3. The uncorrelated case

In the first case that we study, the two creative capital components CI_j^E and CI_j^I in the jth region are uncorrelated. This means that $Cov(CI_j^E, CI_j^I) = 0$. Using this last result in equation (5), we get $\beta = b$. This tells us that an OLS regression of equation (3) will *not* produce a bias. In other words, performing an OLS regression of equation (3) will allow our researcher to ascertain the *true* impact of the jth region's aggregate creative infrastructure on its log income per creative capital unit.[5]

From a policy perspective, the result in the preceding paragraph has two implications. First, consider a policymaker in region j who is interested in determining the true impact that this jth region's creative infrastructure (CI_j) has on the same region's income per creative capital unit (y_j), for the purpose of resource allocation. Our analysis in this section shows that from a determinative standpoint, this policymaker loses essentially nothing by having data only on what we have called this region's physical and scientific infrastructure and no data on this same region's artistic and cultural infrastructure. Second, the same policymaker can ascertain the true incremental impact of a change in the jth region's creative infrastructure on the income per creative capital unit or b by simply knowing the corresponding incremental impact β arising exclusively from the region's physical and scientific infrastructure. We now proceed to study the second and last case where the two components of region $j's$ creative infrastructure are positively correlated.

2.4. The positively correlated case

It is clear that when CI_j^E and CI_j^I are positively correlated, we have $Cov(CI_j^E, CI_j^I) > 0$. Using this last result in equation (5), we get $\beta > b$. This means than an OLS regression of equation (3) will produce an *upward* bias in the estimation. Put differently, with an OLS regression of equation (3), our researcher will be overestimating (underestimating) the impact of what we have called region $j's$ physical and scientific (artistic and cultural) infrastructure in predicting this region's log income per creative capital unit.

From an intuitive standpoint, because the creative infrastructure component for which our researcher has no data varies positively with the infrastructure component for which he does, an OLS regression would result in our researcher incorrectly assigning some of the impact of the artistic and cultural infrastructure to the physical and scientific infrastructure. In sum, the salience of "the arts and culture" in determining region $j's$ log income per creative capital unit would be understated. Having said this, the reader should note that by a simple relabeling of the variables, we can tell that if the situation had been reversed and our researcher had data on this jth region's artistic and cultural infrastructure and not on its physical and scientific infrastructure then this researcher would be exaggerating the salience of "the arts and culture" in explaining the jth region's log income per creative capital unit. This concludes our study of a measurement issue concerning the link between region $j's$ creative infrastructure and its income.

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[5] As noted clearly in both the abstract and in section 1.2, our primary objective in this paper is to study whether an ordinary least squares regression of y_j on a constant and CI_j^E will produce an *unbiased* estimate of the impact of CI_j on y_j in two cases. In this regard, two points are worth emphasizing. First, in the uncorrelated case that we have been studying in this section, we have shown that the OLS estimator β of b is unbiased. Second, even though this unbiasedness result holds, we are not claiming that this estimator is the best linear unbiased estimator (BLUE).

3. Conclusions

In this paper, we analyzed a setting in which the creative capital possessed by the members of the creative class in region j was either acquired through education or present innately in these members. Therefore, the aggregate creative infrastructure (CI_j) in the jth region was the sum of a component (CI_j^E) representing creative capital obtained through *education* and a second component (CI_j^I) denoting creative capital present *innately* in the members of the creative class. A researcher wished to estimate the true relationship between the jth region's log income per creative capital input (y_j) and its creative infrastructure (CI_j). He had data on CI_j^E but not on CI_j^I. We studied whether an ordinary least squares regression of y_j on a constant and CI_j^E would produce an unbiased estimate of the impact of CI_j on y_j in two cases. In the first case, CI_j^E and CI_j^I were uncorrelated. In the second case, CI_j^E and CI_j^I were positively correlated.

The analysis in this paper can be extended in a number of different directions. Here are two suggestions for extending the research described here. First, following the lead of Hall and Jones (1999), it would be useful to analyze the link between a region's log income per creative capital unit and its social infrastructure where the term social infrastructure refers to the "institutions and policies that align private and social returns to activities" (Romer, 2012, p. 162). Second, it would also be instructive to study the income and creative infrastructure link studied in this paper in a more general setting in which there are multiple regions and potential interdependencies between the creative infrastructures present in the different regions being analyzed. Studies that incorporate these aspects of the problem into the analysis will increase our understanding of the nexuses between a region's creative and social infrastructure on the one hand and its log income per creative capital unit on the other.

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